RUNNING HEAD: Postconcussion Symptom Reporting

Postconcussion Symptom Reporting Following Multiple Mild Traumatic Brain Injuries

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Abstract

The relationship between prior mild traumatic brain injury/injuries (MTBI) and recovery from a subsequent MTBI may be complex. The present study investigated three factors hypothesized to influence this relation: (i) the number of prior MTBIs, (ii) the interval between MTBIs, and (iii) the certainty level of prior MTBIs. The study design was retrospective cross-sectional. Participants (N=105) were evaluated at a concussion clinic on average one month after sustaining an MTBI, defined by World Health Organization diagnostic criteria. Approximately half the sample had at least one prior MTBI. Subgroups with 0, 1, or 2+ prior MTBIs did not differ in levels of current postconcussion symptom reporting on the British Columbia Postconcussion Symptom Inventory. Time since the most recent prior MTBI was significantly associated with current postconcussion symptom reporting. This relation was best characterized as logarithmic, i.e., the impact of prior MTBI(s) lessens exponentially as time elapses to a subsequent MTBI. Defining prior MTBIs with a higher certainty level (i.e., probable versus possible) was not consistently associated with greater postconcussion symptom reporting. In conclusion, participants with prior MTBIs did not report more postconcussion symptoms than those with no history of prior MTBI. However, prior MTBI(s) were associated with increased symptom reporting from a subsequent MTBI to the extent they occurred closer in time. Having one or two prior *remote* MTBIs was not associated with worse outcome from subsequent MTBI in this sample.

Key Words: Mild Traumatic Brain Injury; Concussion; Head Trauma; Postconcussional Syndrome; Cumulative Effects

Introduction

Over 30 years ago, Gronwall and Wrightson [1] described a sample of athletes that had longer recovery times following a second concussion compared to athletes who incurred their first ever concussion. Since then, researchers and clinicians have adopted the axiom that prior concussions, or mild traumatic brain injuries (MTBIs), result in cumulative effects and/or delayed recovery from a subsequent MTBI. Synthesizing the recent literature with a meta-analysis, Belanger and colleagues [2] compared people with a history of two or more MTBIs to people with a history of one MTBI. They concluded that the effect of multiple MTBIs (relative to a single MTBI) on overall neuropsychological functioning and self-reported symptoms was minimal and not significant. Follow-up analyses revealed marginally lower neuropsychological performance in selected domains. Even after separating neuropsychological outcome into discrete domains, they found significant heterogeneity of results across studies, leading the authors to propose "important as-yet unidentified moderators" (pg. 266) of the relation between multiple MTBIs and possible cumulative effects.

Several variables have been hypothesized to explain the diversity in outcomes from multiple MTBIs. Perhaps the most widely considered variable is the number of prior MTBIs. At one extreme, numerous MTBIs and subconcussive injuries (e.g., a lengthy professional boxing career) is a possible cause of dementia, [3, 4] or may diminish the threshold for expression of dementia owing to other etiologies. [5] Incurring at least three prior sport-related concussions appears to be associated with lingering neuropsychological deficits and symptoms in some athletes. [6-11] However, most people with a history of prior MTBI(s) tend to have only 1-2 prior injuries. [2] Some athlete studies, [12-14] but not all [15-18] report that a second MTBI is associated with worse outcome relative to a first ever MTBI. Nonetheless, the threshold for the number of prior

MTBIs necessary to adversely impact recovery from a subsequent MTBI is not clear. Because all of the above-reviewed evidence comes from athletes with sport-related MTBI, the clinical significance of prior MTBI history in other settings is especially uncertain. Trauma patients with chronic symptoms after MTBI, identified in prospective cohort studies or because they present to clinic, may have a higher rate of prior MTBI than patients who recover well, [19, 20] but several studies have found similar [21-23] or even lower rates.[24]

In addition to the number of prior MTBIs, the interval between those injuries may help explain the diversity in outcomes from repeated MTBI. [2, 9] In other words, the recency of a previous MTBI may determine its clinical significance. Injuries sustained in very close succession are thought to be of particular concern, based on several lines of research. MTBI appears to induce a cascade of neurometabolic events that devote much of the brain's energy consumption to restorative and homeostatic processes. [25] Normalization of neurometabolic derangement may take several weeks. [26, 27] Rat models with experimentally induced MTBI support that sustaining a second injury during this vulnerable period has synergistic deleterious effects. [28-30] Taken together, incurring a subsequent MTBI within days to weeks of an initial MTBI may be associated with poor outcome. Although the duration between an initial and subsequent MTBI often falls within this period for competitive athletes [31, 32] (but see [14]) and deployed military personnel, [33] this might be less true for those involved in recreational sport, who on average do not incur a subsequent MTBI for at least one year. [34] People who are injured in non-sport settings may have their MTBIs spaced even further apart, on average. The neurobiological consequences and clinical significance of repeated MTBIs spaced months to years apart are poorly understood.

Few observation studies have examined whether the interval between two MTBIs influences outcome from the second injury. In a sample of professional football players (n = 160) who sustained two MTBIs on average one year apart (range = 0 to 5 years), the interval between MTBIs did not correlate significantly with increases in symptoms from the initial to second injury. [14] In military service members (n = 113) with repeated MTBIs on average 40 days apart (range 2 to 753 days), time since previous MTBI did not alter severity indicators of the second injury (e.g., loss of consciousness duration) or health care utilization following the second injury. [33] In these studies, there is little evidence to support a strong linear relation between the recency of a prior MTBI and recovery from the current MTBI. A non-linear relation remains possible, i.e., a relatively recent prior MTBI may be of disproportionate significance.

A third variable that may influence the relationship between MTBI history and outcome from subsequent MTBI is the criterion used to retrospectively identify prior MTBIs. [9, 35] Research studies have, with few exceptions [14] relied on participant self-report to elicit information about prior, often very remote, MTBIs. There are several reasons to doubt the accuracy of retrospective self-report, such as post-traumatic amnesia limiting first-hand recounts and normal forgetting processes that degrade event memory. [36] Even if accuracy is assumed, in some cases, the information provided by the patient offers less than compelling support for a diagnosis of MTBI (e.g., an unwitnessed event with an equivocal alteration in consciousness). To the extent that such a questionable injury event is considered by the researcher to constitute a prior MTBI, past studies may have underestimated the clinical significance of MTBI history. The discrepant and often not explicitly stated diagnostic criteria for prior MTBI in studies to date make this difficult to determine, further hindering our understanding of prognosis following repeated MTBI.

The purpose of this study is to determine whether the clinical significance of repeated MTBIs varies depending on (i) the number of prior MTBIs, (ii) the interval between MTBIs, and (iii) the certainty level of prior MTBIs in a heterogeneous sample of patients referred to a concussion clinic following MTBI. We hypothesized that: (i) there will be an exposure-response relationship between the number of prior MTBIs and current symptom reporting, (ii) more recent prior MTBIs will have a stronger effect on current symptom reporting than a remote prior MTBI, and (iii) self-reported injuries to the head that involved medical indicators of MTBI ("probable") will have a stronger effect on current symptom reporting than those without these features ("possible" MTBI).

Method

Participants

Participants were 105 individuals who met World Health Organization diagnostic criteria for MTBI [37] and were evaluated at a median of 32 days (M = 55.2, SD = 59.9, interquartile range = 20 to 65, range = 2 to 321) following injury. Participants were selected from a larger sample of 137 consecutive cases of physician diagnosed traumatic brain injury referred to two specialty concussion clinics within the Greater Vancouver Regional District (British Columbia, Canada), the G.F. Strong Early Response Concussion Clinic and Fraser Health Concussion Clinic, between January 2007 and December 2009. Participants were excluded if they had a duration of post-traumatic amnesia greater than 24 hours (n=21), Glasgow Coma Scale score of less than 13 after 30 minutes (n=1), or missing data on the primary outcome variable (n=10). The demographic characteristics of the sample and the clinical features of their *presenting* MTBI are summarized in Table 1. Note that the present MTBI sample overlaps with samples reported previously. [38, 39] For many patients, complete medical records were not available for review. For

these patients, classification of MTBI was based on self-reported mechanism of injury, loss of consciousness (LOC), and post-traumatic confusion or post-traumatic amnesia (PTA).

[Insert table 1 about here]

Measures

All participants completed the British Columbia Postconcussion Symptom Inventory (BC-PSI), a self-report measure of postconcussion symptoms. [40] Participants rated symptoms on two dimensions, frequency and intensity, over the past two weeks. The BC-PSI has strong internal consistency and test-retest reliability, [40, 41] and has been used in numerous clinical studies [39, 42-46]. Higher scores indicate greater symptom severity. Prior studies have generated various scores from the BC-PSI. We focused on the BC-PSI total score, which is created by (i) multiplying intensity by frequency ratings for each item, (ii) converting the product to a scale from 0 to 4, and (iii) summing the scaled items scores from the first 13 items. This score has known psychometric properties and is least prone to skewness in clinical samples. Of note, repeating all of the below analyses with another common BC-PSI score (i.e., the number of symptoms endorsed as mild or greater) did not alter the pattern of findings.

Information regarding the participant's demographic background, pre-injury medical and psychiatric history, the day-of-injury events, and compensation-seeking status were obtained by the Service Coordinator using a structured interview. As part of this interview, information regarding prior MTBIs was obtained. The interviewee was first queried about prior MTBIs ("Have you ever had a concussion or mild traumatic brain injury?"). Participants were offered definitions of these terms. If the participant answered positively, the interviewer asked follow-up questions about the injury mechanism, alterations in consciousness, post-traumatic amnesia, medical treatment sought, and the timing of the injury.

Procedure

As part of a clinical intake assessment, all participants completed a battery of standardized questionnaires (that included the BC-PSI) and underwent a structured interview (described above). Prior head trauma events identified by an affirmative response to the initial query ("Have you ever had a concussion or mild traumatic brain injury?") were further classified into probable versus possible prior MTBI. Prior head trauma events were classified as "probable" MTBI if they included an unequivocal loss of consciousness or period of post-traumatic amnesia, or admission to an Emergency Department for suspected concussion or MTBI. If a prior head trauma event included none of these features, or if medical records were unavailable and the participant stated that they did not know or could not recall these details, a "possible" prior MTBI was classified. Medical records were generally not available for remote prior injuries.

After potentially eligible participants completed the clinical intake assessment, their informed consent was sought to include their (de-identified) data in a research database. This research was approved by the University of British Columbia Behavioral Research Ethics Board and Fraser Health Research Ethics Board.

Results

Approximately half (52.4%) of the participants presented with their first ever MTBI. When considering MTBI of any certainty classification (i.e., probable or possible prior MTBI), 28.6% (n=30) had sustained one prior MTBI and 19.0% (n=20) had sustained two or more prior MTBIs. When considering "probable" prior MTBIs only, 11.4% (n=12) had one prior MTBI, and 8.6% (n=9) had two or more prior MTBIs. The time between the current and most recent prior MTBI ranged from 1 week to 55 years, with a median of 7.0 years (M = 11.3, SD = 13.5,

IQR = 2 to 13 years, range = .02 to 55). Only two participants (1.9%) had a repeat MTBI within two weeks.

To determine whether the number of prior MTBIs was associated with outcome from the current MTBI, we compared subgroups with 0, 1, or 2+ prior MTBIs (i.e., combined probable and possible prior MTBIs). The group mean, standard deviations, and effect sizes are presented in Table 2. A one-way analysis of variance (ANOVA) with a three-level independent variable (i.e., 0, 1, or 2+ prior MTBIs) and BC-PSI Total Score as the dependent variable was non-significant, $F(2, 102)=.486$, $p=.617$. Restricting prior MTBIs to "probable" classification yielded a similar null main effect, $F(2, 102)=.196$, $p=.822$. In summary, subgroups with 0, 1, or 2+ prior MTBIs had very similar levels of current postconcussion symptom reporting, regardless of using probable versus possible classification criteria to define prior MTBIs.

[Insert table 2 here]

Of all the demographic and clinical variables listed in Table 1, the groups with 0, 1, or 2+ prior MTBIs were significantly imbalanced only on litigation status (lawyer involved vs. not), chi-square(2)=11.61, $p=.003$. Litigants were half as likely to report a prior MTBI (28% vs. 56%). They also reported greater current postconcussion symptoms [$M=29.3$, $SD=11.8$ vs $M=22.3$, $SD=11.2$; $t(100)=2.99$, $p=.004$, $d = .61$]. To rule out litigation as a confound for the above-reported null effect of prior MTBI history, it was not possible to examine interaction effects due to insufficient cell sizes (n=1 for litigants with 2+ prior MTBIs). Therefore, those in litigation were excluded. For participants who were not in litigation, there was no significant difference in symptom reporting between those with 0, 1, or 2+ prior MTBIs, $F(2, 62)=1.161$, $p=.320$. Descriptive statistics for non-litigants are also presented in Table 2. Note that mechanisms of injury were evenly distributed between participants with 0, 1, or 2+ prior MTBIs [chi-

square(2)=1.31, p=.521] even though litigants were disproportionately likely to have been injured in a motor vehicle accident [chi-square(1)=32.63, p<.001; 66% vs. 14% for non-litigants].

To examine the relation between outcome and the time interval between multiple MTBIs, participants (n=50) were selected who had sustained at least one prior MTBI of any certainty classification (probable or possible MTBIs). Thirteen of these participants had missing data for the time since prior MTBI and were excluded from further analyses (n=37 remained). In this subgroup, the time since prior MTBI (in years) was significantly correlated with current BC-PSI Total Scores, r(37) = -.42, p=.010, indicating that more remote prior MTBI(s) were associated with lesser current symptom reporting. A scatter plot of these data is presented in Figure 1. Time since prior "probable" MTBI correlated somewhat stronger with current BC-PSI Total Scores r(17)=-.53, p.=029. As a group, participants who sustained a prior MTBI of any certainty classification within the last seven years (i.e., below the median split) had greater current BC-PSI Total Scores (n=21, M=28.9, SD=9.8) than participants whose most recent prior MTBI was more than seven years prior to the subsequent injury [n=16, M=19.6, SD=7.7; t(35)=3.13, p=.004, Cohen's d = 1.06 (large effect)].

Generalized linear models were used to explore whether the relation between time since prior MTBI (any certainty level) and current postconcussion symptom reporting was non-linear. We fitted both a standard Gaussian model and a Gaussian model with a log link and compared them. A Gaussian model with a log link fit the data somewhat better than a Gaussian model with an identity link (i.e., ordinary least squares regression), based on a markedly lower Bayesian Information criterion (BIC) (3279.3 vs 3337.9), comparable Akaike Information criterion (AIC) (7.31 vs 7.33), and less heteroskedasticity in the residuals. This pattern suggests that the relation

between time since prior MTBI and current postconcussion symptom reporting may be best characterized by a logarithmic function. That is, the impact of prior MTBI(s) lessens exponentially as time elapses to a subsequent MTBI. This is consistent with a visual inspection of the scatter plot. Line (b) in figure 1 appears to fit the data better than line (a).

[Insert Figure 1 here]

To examine the unique contribution of the number, recency, and certainty of prior MTBIs, variables representing each were evaluated as predictors in a regression model. BC-PSI Total Score was the response variable. Because of its promise in the above-described univariate analyses, time since last prior MTBI was entered in the initial block. This step was significant, R^2 =.416, F(1, 35)=7.33, p=.010. Two variables were simultaneously entered in a second block – certainty classification of the most recent prior MTBI (possible or probable) and total number of prior MTBIs that the participant incurred (as a continuous variable). This step did not significantly improve the model, R^2 change for block = 0.03, F(2, 33)=.706, p=.501. In other words, the variables reflecting the certainty classification of the most recent MTBI and how many MTBIs preceded the current one added minimal useful information over and above the time since most recent prior MTBI.

In a final analysis, we aimed to understand the influence of a recent prior MTBI on postconcussion symptom reporting relative to factors with a previously established association with high symptom severity. We entered recent prior MTBI (<7 years vs. >7 years or no prior MTBI), litigation (lawyer involved vs. not), gender, age, and current MTBI with positive day-of-injury CT scan (vs. negative or not available) as predictors in a regression model with BC-PSI Total Score as the response variable. Loss of consciousness and post-traumatic amnesia duration were not considered because they have been consistently shown to be unrelated to MTBI

outcome [47]. The overall model was significant, $F(4, 96)=4.921$, $p<.001$. Greater symptom reporting was significantly associated with litigation status ($t=2.853$, $p=.005$) and normal/not available CT ($t=-2.175$, $p=.032$). There were also trends for recent prior MTBI ($t=1.932$, $p=.056$) and female gender ($t=1.971$, $p=.052$). Age had very weak unique predictive power in this model ($t=.985$, $p=.327$).

Discussion

Approximately one-third of patients who present to a trauma center with MTBI have had at least one prior MTBI, [19, 21, 48-51] and yet the clinical significance of MTBI history is not well established, especially outside of sports. The present study aimed to better understand factors that might influence the relation between prior MTBI(s) and outcome from a subsequent MTBI. Specifically, these clinically important questions were addressed: (i) how many prior MTBIs does it take to alter outcome from a new MTBI?; (ii) does it matter how recent the last MTBI was?; and (iii) what constitutes a prior head trauma event of clinical significance?

Inconsistent with the first hypothesis, participants with prior MTBIs did not report more postconcussion symptoms compared to those who did not have a history of prior MTBI. There were no differences in postconcussion symptom reporting, at an average of 32 days post-injury, across subgroups classified with 0, 1, or 2+ prior MTBIs. Because participants in litigation were over-represented in the subgroup with no prior MTBIs and they reported greater postconcussion symptoms, we considered litigation status as a potential confound. However, removing the patients who were in litigation did not alter the findings. If not due to chance, the finding that litigants reported fewer prior MTBIs is novel and intriguing. Having personal experience recovering well from a past MTBI may make someone less likely to seek compensation for a subsequent MTBI. Alternatively, litigants may under-report prior MTBIs, intentionally or

through unconscious processes, to strengthen the causal link between their current symptoms and compensable MTBI. These interpretations are necessarily speculative and are offered only to guide future research.

The present study complements a recent meta-analysis of athlete studies that found a non-significant effect of 0 vs. 1+ prior MTBIs on symptom-reporting after a subsequent MTBI [2] by showing a similar null effect in a sample with heterogeneous injury mechanisms. Thus, the best available evidence, at present, suggests that having one or more prior MTBIs does not necessarily confer risk of poor symptomatic recovery from a subsequent MTBI. Note that the present study, like those included in the Belanger et al. meta-analysis, included few participants (13%) with 3+ prior MTBIs, which has been more consistently linked to possible residual effects in some people. [6-11] Given our cross-sectional design, we also cannot rule out that patients with and without a history of repeated MTBIs have different recovery trajectories – they may only begin to diverge at later post-injury time points.

Our second hypothesis, that more recent prior MTBIs are associated with worse outcome, was supported. There was modest evidence to favor a non-linear (logarithmic) characterization of this relationship [depicted by line (b) in Figure 1], suggesting that the association between a prior MTBI and symptom reporting following a subsequent MTBI weakens as the time between them increases, rapidly at first and slower thereafter. Using a median split based on time since previous injury, those injured in the past 7 years had much higher total scores on the BC-PSI than those injured more than 7 years ago ($d = 1.06$). These findings require replication, but could have important implications for research. It highlights the need for caution in extrapolating sport-related concussion research to other MTBI populations, because athletes tend to have repeat MTBIs more closely spaced [31, 32] (but see [14]), which may overestimate the effect of prior MTBIs

in non-athletes. It also points to a knowledge gap that requires attention. Neurobiological mechanisms proposed to underlie recovery from close proximity MTBIs (i.e., between injury intervals of less than two weeks) [26, 52] appear unable to explain how a prior MTBI can adversely impact recovery from a subsequent MTBI months to years later, as was the case in our study.

We also hypothesized that different criteria used to identify prior MTBIs might explain significant variability in outcomes from subsequent MTBI. It was assumed that past head traumas associated with loss of consciousness, post-traumatic amnesia, or an Emergency Department admission would increase the likelihood that a prior head trauma event was actually an MTBI. Retrospectively reported prior head trauma events with these features (i.e., "probable" MTBI) should have a greater impact on outcome than prior MTBIs without these features. The findings were mixed. Probable prior MTBIs were not associated with a stronger exposure-response effect, but did strengthen the recency effect somewhat. Most prior studies did not make the distinction between likely MTBIs and other minor head trauma events, suggesting that extra caution is warranted in interpreting their findings.

A diverse range of biopsychological factors have been previously shown to correlate with postconcussion symptom reporting, such as litigation and, with less consistency, age, gender, and CT abnormalities [40, 47]. In this broader context, a history of prior MTBI within the past few years had unique importance. Its relation with postconcussion symptom reporting after a subsequent MTBI in the present sample could not be explained by litigation, gender, age, or severity of the subsequent MTBI (defined by presence/absence of intracranial abnormalities). In other words, the effect of MTBI history was not overshadowed when considered alongside these empirically established covariates. Recent prior MTBI may therefore represent another characteristic of the minority of patients who recover more slowly and/or less completely from MTBI. [53]

The present study involved a heterogeneous clinic-referred sample, where most participants had less than three prior concussions, without medical documentation, spaced over years, incurred in various settings (e.g., motor vehicle accident, fall, recreational sport). The results should therefore generalize to patients presenting to a concussion clinic or community-based rehabilitation center. However, several limitations need to be considered. The present study did not comprehensively examine potential moderators of outcome from repeat MTBI. The recency of a prior MTBI may be one of several moderating factors. Age at first injury and genetic factors (e.g., APOE E4 allele status), for example, may also contribute to the heterogeneity in outcomes. [54] We also did not obtain objective measures of neurological recovery (e.g., magnetic resonance spectroscopy, neuropsychological testing) or consider the full range of potentially important adverse outcomes from repeated MTBI, such as increased risk of incurring further MTBIs or developing dementia. [55] Rather, we focused on postconcussion symptom severity at first clinic visit following a subsequent MTBI. Our findings are therefore limited to this narrow aspect of MTBI outcome. A further limitation of our study was the unavailability of detailed medical records for both current and prior MTBIs in most participants, necessitating an over-reliance on self-report. This is a methodological limitation in the vast majority of studies involving recurrent MTBI in athletes, civilians, and service members. To improve the reliability of our MTBI ascertainment method, we used medical records when available. A disadvantage of this mixed method approach is that prior MTBI could be confirmed with differing levels of certainty across participants. Although a strong reliance on self-report is likely reflective of clinical practice (i.e., supports external validity), it further attenuates the strength of our conclusions. The field needs a standardized and comprehensive method of assessing MTBI history. The Ohio State University TBI Identification Method is one solution for this need [56]. Its

adoption as a Common Data Element in MTBI research [57] should facilitate its widespread use, particularly in future studies of repeated MTBI. Finally, like virtually all prior studies of repeated MTBI, our cross-sectional design precludes causal inferences.[9]

With these limitations in mind, the present study revealed no clear evidence of cumulative effects of 1-3 prior MTBIs on postconcussion symptom reporting in trauma patients presenting to clinic, when collapsing across time since prior injury. However, those injured in the past few years, compared to those with more remote prior injuries, reported greater symptoms at their first clinic visit for a subsequent MTBI. We tentatively conclude that prior MTBI(s) appear to complicate symptom resolution from a subsequent MTBI to the extent they occur more recently, versus remotely. The underlying mechanisms relating to increased post-acute symptom reporting, in those who had prior injuries in recent years, are unknown and might be biopsychosocial.

The present study has clinical implications. It highlights the need for a detailed assessment of prior MTBI exposure and to specifically consider the timing of prior MTBI(s) in prognosis and treatment planning. Whereas a more recent history of MTBI (months or few years) might be related to symptom reporting and recovery, remote MTBIs may be of less significance in most patients. However, until a more definitive evidence-base emerges, a relatively guarded prognosis and conservative clinical management is reasonable for patients with repeat MTBI.

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Author Disclosure Statement

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Table 1. Demographic and clinical characteristics of the sample.

Table 2. Descriptive statistics and effect sizes for BC-PSI Total Scores.

Figure 1. Current postconcussion symptom severity (BC-PSI Total Scores) plotted against time since prior mild traumatic brain injury.

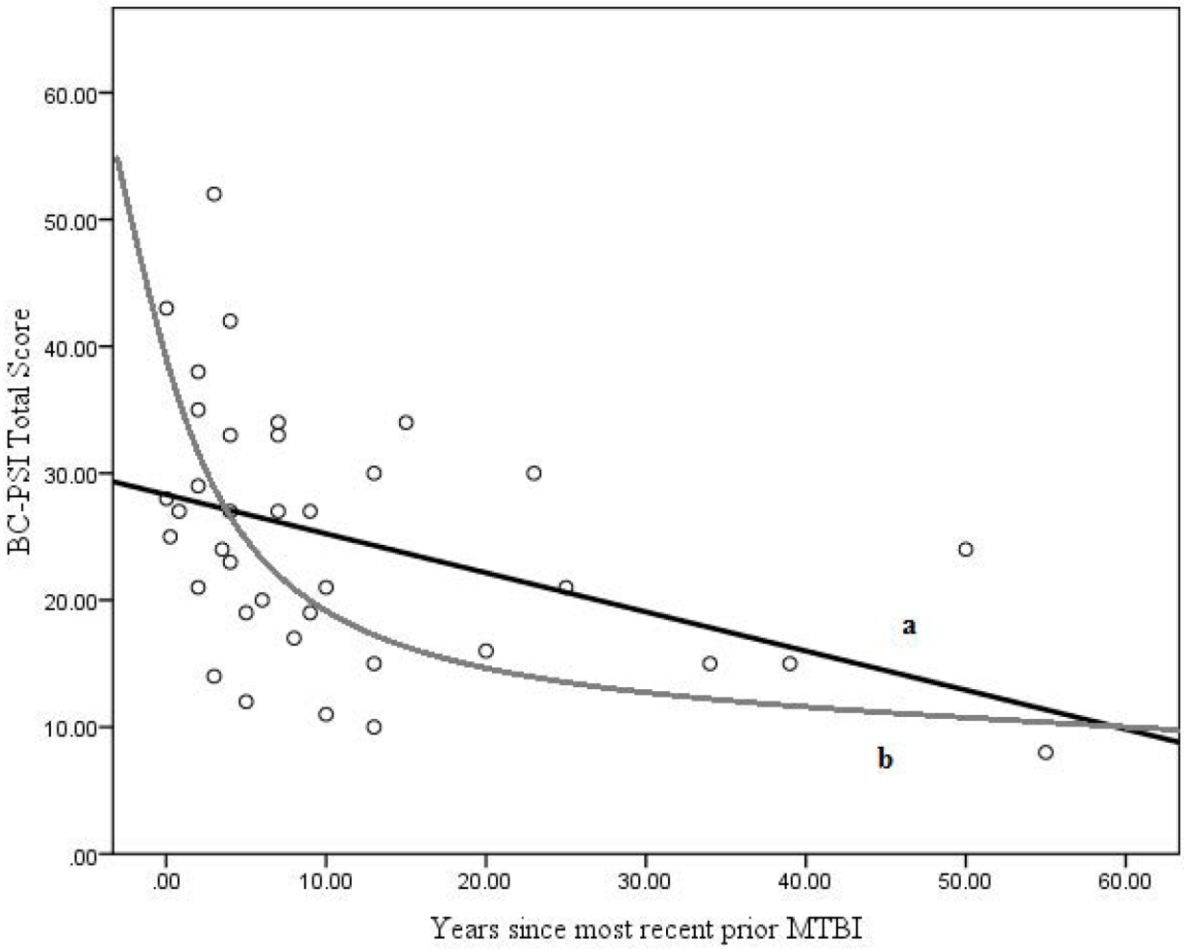

Figure 1 Legend:

a = Best-fitting linear line

b = Best-fitting logarithmic line

Table 1. Demographic and clinical characteristics of the sample.

Age	M = 36.2, SD = 13.8
Gender	Men = 55 (52%)
Education	> 16 years = 11 (10.5%) 16 years = 33 (31.4%) 13-15 years = 40 (38.1%) 12 years = 13 (12.4%) < 12 years = 8 (7.6%)
Ethnicity	Caucasian = 75 (71.4%) Asian = 15 (14.3%) Other = 15 (14.3%)
Litigation	Active = 36 (34.3%) No = 46 (43.8%) Undecided = 14 (13.3%) Unknown = 9 (8.6%)
Glasgow Coma Scale score	15 = 14 (13.3%) 14 = 10 (9.5%) 13 = 0 Not available = 81 (77.1%)
Loss of consciousness	Positive = 73 (69.5%) Negative = 30 (28.6%) Unknown = 2 (1.9%)
Post-traumatic	None = 37 (35.2%)

amnesia duration	<1 min = 28 (26.7%) 1 min to 1 hour = 15 (14.3%) 1 hour to 24 hours = 25 (23.8%)
CT scan	Normal = 40 (38.1%) Abnormal = 17 (16.2%) Not ordered = 10 (9.5%) Unknown = 38 (36.2%)
Mechanism of injury	Motor vehicle accident = 30 (28.6%) Recreation/sport = 28 (26.7%) Fall = 20 (19.1%) Assault = 21 (20.0%) Other = 6 (5.7%)

Table 2. Descriptive statistics and effect sizes for BC-PSI Total Scores.

		N	M	SD	Cohen's d
All	0 prior MTBIs	55	25.1	13.1	0 vs 1 = -0.05
	1 prior MTBI	30	25.8	11.5	1 vs 2+ = 0.32
	2+ prior MTBIs	20	22.5	9.0	0 vs 2+ = 0.23
Non-Litigants Only	0 prior MTBIs	28	20.1	12.0	0 vs 1 = -.43
	1 prior MTBI	19	25.2	11.9	1 vs 2+ = .27
	2+ prior MTBIs	18	22.4	9.0	0 vs 2+ = -.21
Probable Classification Only	0 prior MTBIs	84	25.2	12.4	0 vs 1 = 0.11
	1 prior MTBI	12	23.9	10.8	1 vs 2+ = 0.11
	2+ prior MTBIs	9	22.8	9.4	0 vs 2+ = 0.22

BC-PSI = British Columbia Postconcussion Symptom Inventory

MTBI = Mild traumatic brain injury

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